

Soil and Leaf Analyses in Relation to the Nutrition of High Yielding Coconut Genotypes

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Abstract

Seasonal changes in the nutrient composition of index leaf and available nutrient status of a ten year old coconut plantation on acid sandy loam soil were evaluated in three high yielding coconut genotypes (West Coast Tall, Tall×Dwarf, and Dwarf×Tall) growing under three fertilizer levels. Seasonal changes in leaf nutrients status confirmed that the fourteenth leaf could be taken as the index leaf under the local conditions. Available K was a limiting nutrient which was reflected in deficient K concentration in leaf of control plots. An inverse relationship between K and Mg content of leaf was observed. Leaf concentration of N was not significantly influenced by fertilization. Even at the highest level of fertilizer application was below the critical limit proposed by IRHO. However, yield data indicated that the critical limit could possibly be lowered to suit the West Coast of India conditions. No significant variation was observed in P content of leaves due to fertilizers or genotypes. Fixation of P in the soil appeared to be accentuated during monsoon months. NPK fertilization increased the concentrations of Mn, Zn, Fe, and Cu in the leaf while that of Ca, S, B, and Mo were unaffected.

Introduction

Yield performance coupled with soil and/or leaf analyses are usually taken into account for developing suitable manurial schedules for field crops. In the coconut, the technique of leaf analyses has been developed by the IRHO in Ivory Coast and this has made it possible to establish critical limits for different nutrients and consequently to adjust manuring to maintain the nutrient status at adequate levels. From the management point of view, this approach amounts to 'fertilizing the crop' as against 'fertilizing the soil'. This paper brings out the need and relevance of soil and plant analyses in the mineral nutrition and long term management of coconut plantations.

Material and Methods

The information presented in this paper is drawn from a field experiment

initiated in 1965 in this Institute to determine the response of three genotypes (West Coast Tall, Tall \times Dwarf, and Dwarf \times Tall) to three levels of NPK fertilizers on red sandy loam soil. It is laid out in a randomized block design with three replications and six palms/plot. The three levels of NPK fertilizer are F_0 : 0-0-0; F_1 : 500-500-1000; and F_2 : 1000-1000-2000 g/palm annually with N applied as ammonium sulphate, P as superphosphate, and K as muriate of potash. One-third of the annual dose is surface applied in April-May before the onset of the south-west monsoon rains and raked in. The remainder is spread during September-October in the basins of palms within a radius of 1.8 m after removing the top 25 cm soil which is put back after fertilizer application. Leaf and soil samples for the study were collected in 1975. Leaf samples (totalling 162) were collected at bimonthly intervals using 14th leaf as the index leaf (cf. Chapman, 1964). Soil samples (totalling 81) were collected three times during the year in January, May and September from the basins of palms from the top 0-50 cm layer from a distance of 1m from the palm. Standard analytical procedures were followed (cf. Black *et al.*, 1965; Jackson, 1967).

Results and Discussion

Leaf analysis. The seasonal variation in the concentration of nutrients in the index leaf was negligible (cf. Table 1). This was so in both fertilized and unfertilized palms. There was also no appreciable difference among the three genotypes in the leaf content of different elements.

The effect of fertilization on the foliar status of nutrients was a very significant increase in K, a very modest increase in N, and hardly any change in P (Table 1). Leaf analyses carried out on these palms in

TABLE 1. Concentration of nutrients in 14th leaf*

Nutrient level	F_0	F_1	F_2
N%	1.43-1.62	1.46-1.80	1.47-1.61
P%	0.111-0.123	0.121-0.127	0.122-0.130
K%	0.40-0.56	0.74-1.17	0.99-1.41
Ca%	0.29-0.34	0.30-0.34	0.30-0.33
Mg%	0.31-0.39	0.28-0.35	0.23-0.37
S %	0.85-0.96	1.14-1.17	1.15-1.21
Fe—ppm	273-328	282-339	302-481
Mn—ppm	389-485	635-757	808-945
Zn—ppm	13.0-14.6	26.2-28.2	30.8-37.5
Cu—ppm	11.6-12.0	20.6-21.2	22.7-23.5
B—ppm	13.6-15.7	14.0-14.7	14.4-15.0
Mo—ppm	0.67-0.77	0.73-0.77	0.70-0.77

*Each value is mean of nine determinations.

1971 indicated that fertilisation at F_2 level increased the leaf N content from 1.40% at F_0 to 1.55% (Kamala Devi, 1972). In the present analysis, the leaf N concentration was below the critical limit of 1.8% set by the IRHO (cf., Fremond, 1964) even at the F_2 level. It seems that this limit of 1.8% N is on the upper side for at least the west coast of India. The response of WCT palms to fertilizers was linear upto the F_2 level, but in the hybrids it was so upto the F_1 level only. One of the reasons for the lack of increase in N level in the leaf may be due to the depletion from foliage through heavy rainfall experienced in this tract. Preliminary studies by Cecil and Pillai (1973) indicate such a possibility.

The most marked effect of fertilisation on foliar status was for K. The K concentration of leaf in F_0 plots was well below the critical limit of 0.8% in all instances. This was raised to sufficiency level in palms which received fertilizers. The foliar diagnosis of K deficiency has been successfully used in Ivory Coast to increase copra yield from 1 to 2 ton/ha (Ziller and Prevot, 1962).

The effect of NPK fertilization on Mg level was that it decreased with increase in the level of manuring. Ziller and Prevot (1962) have pointed out that K-Mg antagonism was pronounced when leaf K concentration was above 0.55. This trend points out that regular K fertilisation on soils having a low cation exchange capacity (5.5 me/100 mg) may soon bring out the antagonism between K and Mg which may have negative effect on number of bunches (cf. Fremond, 1964).

Among the trace elements, the leaf content of Mn, Zn, Cu, and Fe increased with NPK fertilization. The leaf status of B and Mo remained unchanged.

Soil analysis. No information is available on calibrating soil nutrient status with yield of nuts. The available nutrient levels in the soil is given in Table 2. The built up of K in soil is reflected in higher leaf K content in fertilized palms. A comparison of soil available nutrient status between 1971 and 1975 indicate a build up in P, but not in N and K. The fixation of P appears to be accentuated in acidic soils (pH 4.3-5.1) during the monsoon months June to September. Such a phenomenon of alternate fixing and release of P as the season changes from wet to dry has been observed also in laterite soils by Muliar and Wahid (1973). This suggests for a change in the time of application of P fertilizers to after the south-west monsoon in order to enhance its availability. This needs further experimental verification.

Changes in the level of secondary nutrients in the soil due to NPK fertilization showed more or less a similar trend as in leaves. The exchangeable Mg level slightly decreased in fertilized plots which also explains the low Mg status in the leaf in such palms. Among the trace elements, a slight increase in Fe and significant increase in exchangeable Mn, and an absence of any effect on Zn, Cu, B, and Mo were noticed. The former effect is mainly due to the lowering of pH in fertilized plots from 5.3 to

TABLE 2. Variations soil nutrient content under different levels of fertilizers

Nutrient level (ppm)	F ₀	F ₁	F ₂
N	414-434	424-462	434-452
P	17-21	53-75	142-195
K	15-22	38-45	50-64
Ca	425-435	430-436	439-452
Mg	145-156	123-147	106-129
S	34-35	47-48	51-53
Fe	1.2-1.5	1.6-2.1	2.2-2.6
Mn	7.6-8.5	13.0-14.4	13.8-14.8
Zn	2.9	2.8-2.9	2.9-3.0
Cu	0.93-0.95	0.89-0.96	0.92-0.97
B	0.24-0.25	0.24-0.25	0.27-0.30
Mo	0.02-0.03	0.02-0.03	0.02-0.03

N—total N; P—Bray's P; K, Ca, Mg, and Mn—with 1→1 amm. acetate (one normal acetate) N ammonium acetate (pH 7.0); S—with Margan's reagent; Cu—with 0.02 N EDTA; B—hot water soluble; Mo—with Tamm's reagent; Zn—with dithizone.

4.0. The implications of this on the trace element nutrition of coconut has been discussed by Kamala Devi *et al.* (1975) which is corroborated by the results from the present study.

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Discussions

- Thomas : 1. How did you arrive at the 14th leaf as the best index leaf ? Is it based on analysis and comparison in levels of other leaves also?
2. Will your study lead to fixing or critical levels of nutrients in coconut leaves under Indian conditions?
- Velayutham : 1. The stability of nutrient concentration round the year in the 14th leaf was originally proposed by IRHO. This has been confirmed by the CPCRI for West Coast (Kerala) conditions also. Comparison with nutrient levels in other leaves was not made.
2. This is envisaged in the full programme of the investigation to be carried out within the next few years.
- Venkateswaran : Information was furnished on the results of a manurial experiment carried out by the Veppankulam Coconut Research Station in farmers' fields. K at 450g/palm gave a significant response, whereas at 900g, the response was slightly negative probably due to the synergistic action of K and Mg in the former and antagonistic effect in the latter.
- Velayutham : I agree with this conjecture. But it has to be confirmed by leaf analysis for both K and Mg at different levels of applied K.
- Narasimhayya : Did the response curves of yields of nuts of the three genotypes reach the plateau with the three doses of fertilizers? What are the differences among their curves?
- Velayutham : The response curves of the two hybrids show a plateau between F2 and F3 levels, whereas that of the WCT is linear upto the F3 level. However, since the palms are in the early bearing stage, yield data are available for a few years only.
- Fremond : Did I understand correctly that N application brought about N increase in the leaf, but no response in the palm in terms of production?
- Velayutham : Application of N along with P and K produced a nonsignificant increase in leaf concentration and significant increase in nut production. Even at the highest level of fertilizers, N content of leaf was below the critical limit proposed by the IRHO.